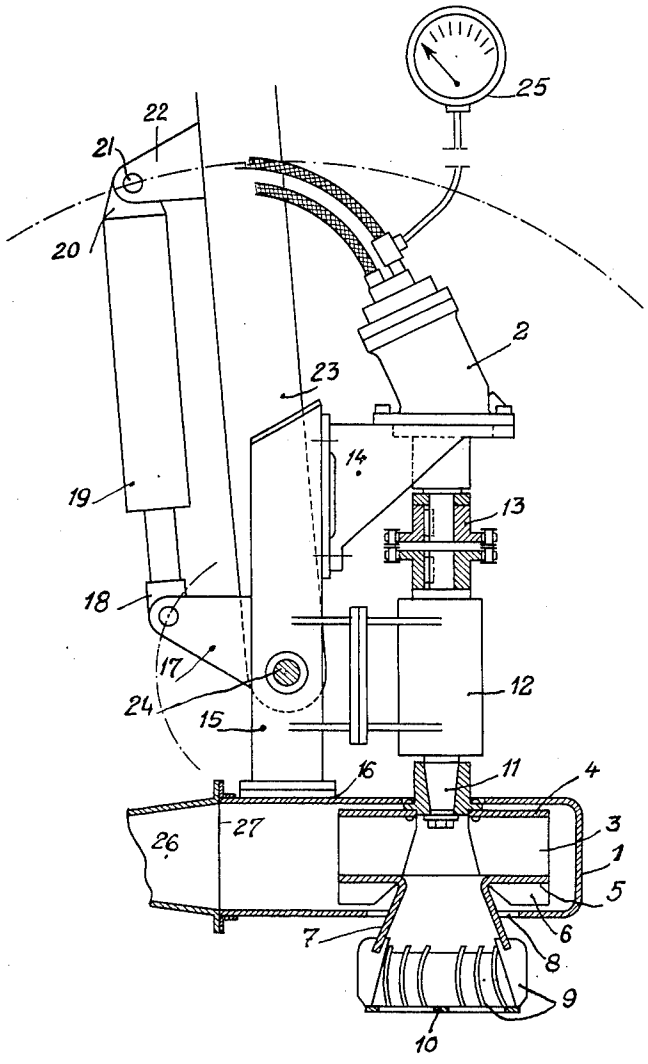
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# UNDERWATER EXCAVATING DEVICE

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*Fig. 1.*



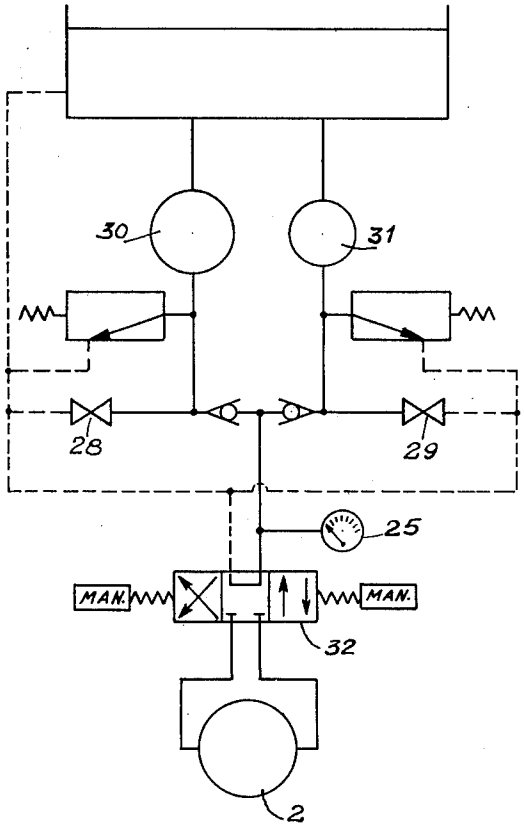

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*Fig. 2*




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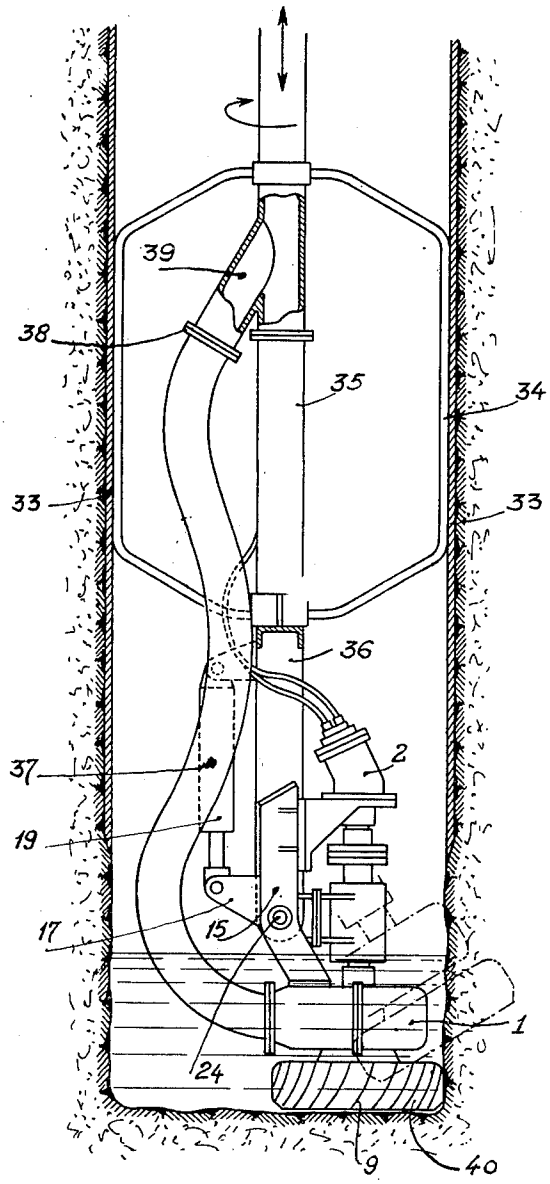
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# UNDERWATER EXCAVATING DEVICE

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*Fig. 3*




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UNDERWATER EXCAVATING DEVICE

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Fig. 4

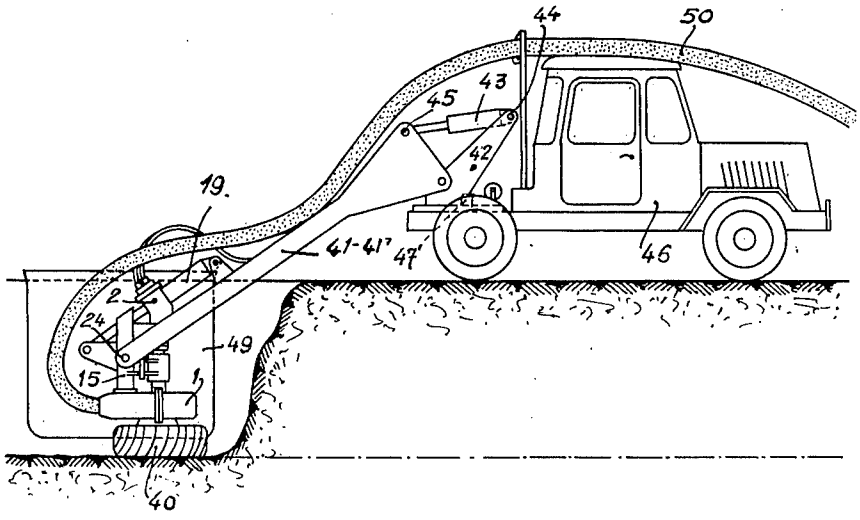
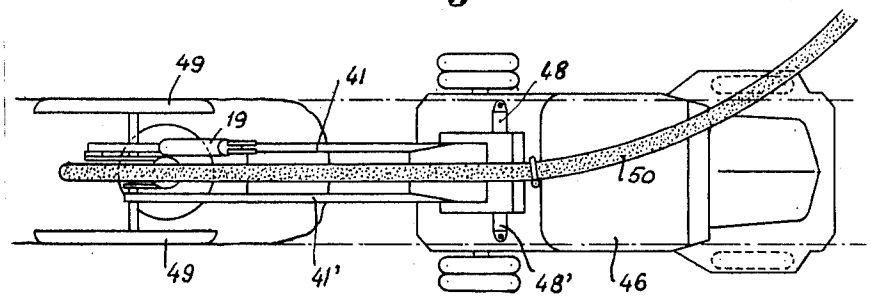



Fig. 5




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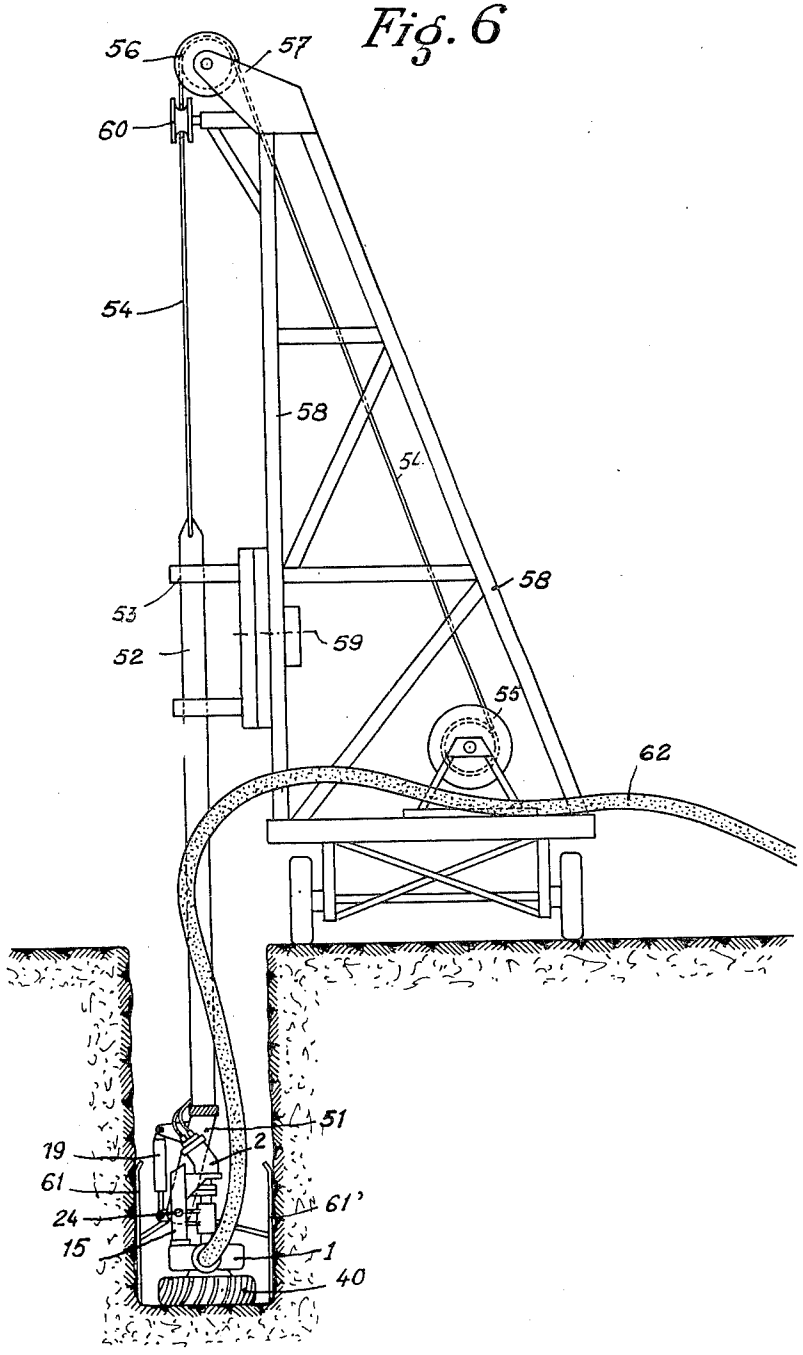
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UNDERWATER EXCAVATING DEVICE

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Fig. 6




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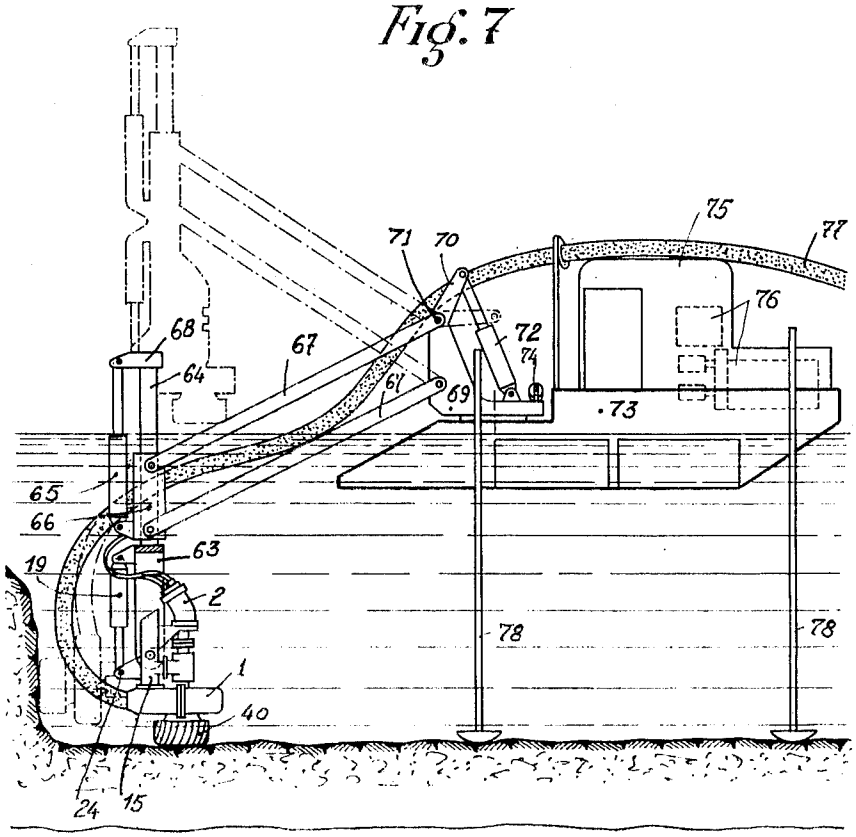
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UNDERWATER EXCAVATING DEVICE

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Fig. 7



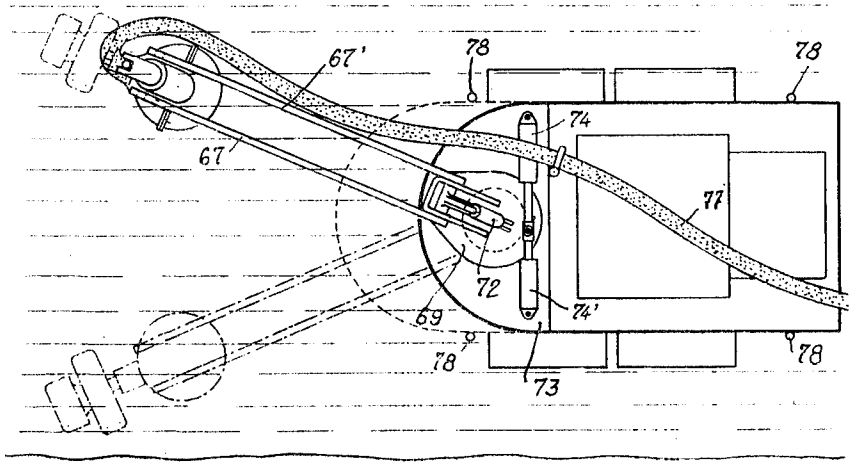




Fig. 8

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United States Patent Office 3,253,357 Patented May 31, 1966



3,253,357

# UNDERWATER EXCAVATING DEVICE

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Filed May 27, 1963, Ser. No. 283,204
10 Claims. (Cl. 37—65)

My invention relates to hydraulic apparatus for digging, breaking up and removing waste material, applicable in particular for the removal of alluvial material and clay, during boring, trench-digging and dredging work.

My invention has more particularly for its object a pump and control means therefor, of a simple execution and of a great adaptability in operation, said pump including a turbine of a novel design driven directly by a electric or hydraulic motor or energy receiving unit, which turbine is carried by an arrangement which allows giving it an angular setting controlled, generally speaking, by a hydraulic jack, said angular setting or slope providing an optimum angle of engagement. Said optimum angle leading to an optimum yield is controlled at a control station, either through a pressure gauge in the case of a hydraulic operation or else through an ammeter and a wattmeter in the case of an electric operation.

According to a main feature of my invention, my improved centrifugal pump or turbine is housed inside a casing. Said turbine includes an inner row of helical blades housed between two flanges, the lower flange being provided with smaller blades adapted to urge the material into a central suction cone. Said central cone is equipped along its lower edge with helical ridges forming a cutter acting as disagregating means. Said turbine of a stepped outline, is driven directly, either by an electric motor or by a hydraulic motor fitted on a bearing rigid with a bracket to the lower end of which the casing enclosing said turbine is secured.

According to a further feature of my invention, said bracket secured to a pivot extending between the tines of a fork-shaped support, is subjected to the action of a control jack. Said jack carried by said support and acting on an arm rigid with the bracket carrying the driving means and the turbine rocks the latter with reference to the forked support so as to adjust it at its optimum angle of engagement with the ground in conformity with the information supplied by a measuring instrument.

According to a preferred manner of executing the apparatus for removing material contained in a bore hole or well, said apparatus may be carried at the end of an arm guided inside a boring tube.

According to a second application of the apparatus with a view to digging trenches in clay or alluvial grounds, said apparatus may be fitted on a support such as a turret a rigid with a carriage, the jib of a crane, or any like apparatus.

According to a still further application of my improved apparatus intended for the dredging of rivers or ponds, said apparatus may be fitted on a boat.

Various other advantageous features of my invention will appear from the reading of the following detailed description.

A preferred embodiment of my said invention and its different applications are illustrated by way of examples and in a non limiting sense in the accompanying drawings wherein:

FIG. 1 is an elevational view of a first embodiment of said apparatus,

FIG. 2 is a diagrammatic view of a hydraulic circuit controlling the receiver driving the turbine,

FIG. 3 illustrates a first application of the apparatus designed for the boring of bore holes,

FIGS. 4 and 5 illustrates in elevational and plan views



a second application of the apparatus designed for the digging of trenches,

FIG. 6 illustrates a modification of said second application adapted for the digging of trenches,

FIGS. 7 and 8 illustrate in elevational and plan views, a third application of the apparatus intended for the dredging of rivers, streams, ponds and the like.

Referring to FIG. 1, the apparatus comprises a casing **1** inside which is housed a centrifugal pump driven directly by an electric or hydraulic motor **2** or similar device.

The pump comprises an inner row of helical blades **3**, extending between two vertically spaced flanges **4** and **5**, and associated with a further row of depending smaller blades **6**, fixed to the lower surface of the flange **5**. The smaller blades **6** are adapted to draw in material from the outside of the central suction cone **7**. For this purpose, a circular opening **8** of a diameter larger than cone **7**, is provided in the casing **1** of the pump.

The central cone **7** is equipped along its lower edge with helical blades **9** forming a cutter acting as a digging tool. The cutter blades **9** are interconnected along their lower edges through a grid or spider **10** preventing the entrance into the cone of any material too large to pass through the cone **7** and pump blades **3**.

The pump rotor is secured to a shaft **11** guided by a roller bearing **12** and is connected with the motor **2** through a coupling sleeve **13**.

The motor **2** is mounted on a support **14**, rigid with a bracket **15**, to which the bearing **12** is secured while the casing **1** is secured to the lower end **16** of the bracket. Said bracket carries a lateral projection **17** to which is pivotally secured the free end **18** of the piston rod of a hydraulic ram or jack **19**.

The other end of the jack **20** is secured by a pivot pin **21** extending between two plates **22** rigid with two arms forming a bifurcated supporting unit **23**. The ends of the arms of lower free unit **23** carry a pivot pin **24** supporting the bracket **15** to which the turbine and its driving means are secured.

The pivotally movable supporting structure thus formed is angularly adjustable and allows angular adjustment of the pump in the desired operative position. The angular attitude or position is controlled by the jack **19**.

The amount of power delivered to the pump rotor blades **3**, **6** by the motor **2** corresponds to a hydraulic pressure, to an electrical input in kilowatts and is recorded by the pressure gauge or wattmeter **25** located in convenient proximity to the operator at the control station and the operator may, according to the information provided as to the power and/or pressure to be supplied, adjust the valves controlling the hydraulic jack **19** so as to give the rotational axis of the cutter blades **9** an optimum inclination with respect to the vertical.

A discharge tube **26** of a suitable diameter and length connected to a port **27** of the pump housing, provides means discharging material collected by the pump blade **3**, **6** and cutter **9**.

As illustrated in FIG. 2, the hydraulic circuit controlling the receiver driving the turbine is adjusted by the operator who may, as required, regulate the valves **28–29** so as to connect, as desired, the outputs of the two pumps **30** and **31**, which outputs have different constant values, to obtain thus three ranges of speeds for the receiver **2**, to wit: through the use of the pump **31**, a high speed, through the use of the pump **30**, an intermediate speed and through the differential connection of the pumps **30** and **31**, a low speed.

The three-position master control valve **32**, which is manually controlled, provides for forward rotation, stopping and reverse rotation of the pump and cutter, the

reversed rotation being used for unblocking jamming, if required.

In a first application (FIG. 3), intended for the boring of bore holes, the apparatus may be sunk inside the bore hole **33** and maintained centrally positioned therein by three or four guide members constituted by bars **34** fitted on a central tubular support **35** terminating at its lower end in a bifurcated supporting unit **36**.

The supporting unit **36**, carries the pivot pin **24** to which is pivotally secured a pivotally movable supporting structure which is identical above with that described with reference to FIG. 1 and which is controlled by the jack **19**. The removal of the excavated material is through a flexible hose **37** communicating through a flanged connection **38** and a branch pipe **39** of a V-connection into the central tubular support **35**, which thus also serves to convey the excavated material out of the bore hole.

The central tubular support on which the pump is fitted, may be rotated through one complete revolution, so as to allow the cutter **9** of tool **40** to engage all portions of the bottom surface of the bore hole.

The diameter of the cutter **9** tool is larger than that of the casing **1** of the turbine, and it projects outwardly beyond the casing **1** so that cutter **9** is the only portion of the pump in contact with the bore hole wall.

An upwardly and outwardly directed inclination of the cutter **9** (as illustrated in dot and dash lines) provides for increasing the diameter for the bore hole. An upwardly and inwardly directed inclination of the cutter **9** permits the apparatus to cut downwardly inside the bore hole, without cutting the wall of the bore hole, since only the guiding members **34** are in contact with the wall as they slide downwardly inside the bore hole.

The tubular support **35** carrying the cutter **9** may be vertically reciprocated within the bore hole by suitable means (not shown).

FIGS. 4 and 5 illustrate in elevational and plan views, a second application of the apparatus arranged for the digging of trenches.

According to said second application, the pivotally movable supporting structure is the same as that described above with reference to FIG. 1. It is carried by two parallel arms **41–41'** forming a bifurcated unit adapted to be lowered within the trench. The arms **41–41'** are pivotally secured to a turret **42** and their vertical adjustment is controlled by a hydraulic jack **43** pivotally connected on the one hand with the upper end **44** of the turret **42** and on the other hand, with a pin **45** connecting the arms **41–41'** with each other.

The entire apparatus is mounted on a vehicle or carriage **46** which may be driven either along the center of the trench or along its side.

The diameter of the cutting tool **40** is slightly smaller than the breadth of the trench, but the supporting arms **40** and **41'** provide for lateral movement, since the turret **42** can rotate about a vertical axis on pivot **47**, rigid with the carriage, under the action of the transversely extending hydraulic jacks **48** and **48'**.

At the point where the turbine operates, two removable panels **49**, rigid with the swing-frame define the breadth of the trench and prevent the tool **40** from undermining the trench walls.

The flexible tube **50** through which the excavated material is exhausted may extend over the distance required so as to reach the point at which said materials are to be discharged.

Turning to FIG. 6 illustrating a modification of the preceding trench digging application of the apparatus, the apparatus is mounted on a crane-carrying carriage for digging trenches in clay or alluvial grounds in a water-laden soil.

The angularly pivotally movably supporting structure is the same as that described above with reference to FIG. 1, and it pivots on a pin **24** extending between the arms or tines of a bifurcated member **51** carried in its turn by an upright **52** which is vertically adjustable. Said upright slides within a guide **53** being supported by a cable **54** controlled by a winch **55**, said cable passing over a pulley **56** carried by the jib **57** on the vertical frame **58**.

Furthermore, frame **58** carries the guide **53** for the upright **52** and guide **53** is angularly adjustable about a horizontal axis provided by a pivot **59** so as to allow imparting a swinging movement to the tool **40**. It is thus possible to dig a certain length of trench without moving the carriage. During said swinging movement, the cable which is urged laterally is guided between two pulleys **60** located below the pulley **56**.

Two lateral panels **61–61'** secured to the bifurcated member **51** and located at each side of the tool **40**, prevent the latter from increasing its suction area beyond the desired width to be given to the trench. The width is controlled by giving a series of different inclinations to the tool **40** the inclinations being controlled by the jack **19**.

Obviously, the upright **52** may be given any suitable cross-section, whether square, triangular or hexagonal so as to hold the lateral panels in position in the longitudinal direction of the trench and it may, on the other hand, be of a telescopic type so as to allow an increase in the depth of operation.

The flexible removal tube **62** extends to the location at which the excavated material is deposited.

In accordance with a third application illustrated in FIGS. 7 and 8, the apparatus may be arranged to dredge rivers, streams, ponds and the like.

As shown in FIGS. 7 and 8, the pivotally movable supporting structure is the same as that described above with reference to FIG. 1 and it pivots on a pin **24** extending between the tines of a bifurcated member **63**. The bifurcated member **63** is rigid with a rod **64**, sliding vertically under the control of a double acting hydraulic jack **65** inside a sheath **66**, carried in its turn by a boom comprising four arms **67** pivotally connected to form a parallelogram linkage.

The body of the jack **65** is secured to and pivots on the lower portion of the sheath **66** while the piston rod of jack **65** is connected to the rod **64** by a connecting member **68**.

The arms **67** of the boom are carried by a turret **69**. The two upper arms are rigidly connected by a common shaft **71** to a lever **70** pivotally connected to the piston rod of a double acting hydraulic jack **72** the body of which is pivotally connected to the turret **69**. The jack **72** controls the boom arms **67** and permits raising and lowering the tool **40** as desired.

The parallelogram linkage arrangement of the boom arms **67** causes the tool **40** to maintain its inclination unchanged during the rising or lowering of the boom.

The vertically movable rod **64** allows the tool **40** to reach a considerable depth.

The turret **69** is rotatably supported on a floating frame or boat **73** and is adapted to pivot above a vertical axis under the control of two hydraulic jacks **74–74'**. This arrangement permits the tool **40** to move horizontally along an arcuate path, as illustrated in FIG. 8.

The boat includes a wheelhouse **75** inside which is located a control station. The wheelhouse **75** also contains the hydraulic system **76** which supplies pressure fluid to the motor **2** of the tool **40** and controls the movements of various jacks.

The flexible tube **77** extends to the location where excavated material is to be discharged.

The stability of the whole system may be enhanced by poles **78** of an adjustable height, engaging the bottom of the water and secured to the boat after adjustment.

When the apparatus is used in marshy land and in soil into which water has entered to some considerable extent, it is possible to fill the ground with bentonite or other similar filling material.

Obviously, various modifications may be made in the embodiments disclosed, without departing from the spirit

and scope of the invention as defined in the appended claims.

What I claim is:

1. An underwater earth excavating device comprising: a pump casing; a pump rotor within said casing, said casing having an outlet formed therein; a hollow frustoconical inlet member coaxial with said rotor, the smaller base portion of said inlet member being connected to the inlet portion of said rotor for rotation therewith; means defining an annular aperture in said casing coaxially surrounding said inlet member intermediate its ends; separate blades included in said rotor and surrounding said aperture within said casing for delivering material exteriorly of said inlet member from said annular aperture to said outlet; an annular series of cutter blades carried by the larger base portion of said inlet member exteriorly of said housing, said cutter blades extending generally radially outwardly beyond said inlet member for cutting engagement with the earth to be excavated; and motor means for driving said rotor.

2. A device according to claim 1, further comprising selectively operable control means connected to said motor means for driving said rotor in either direction.

3. A device according to claim 1, further comprising pivotally movable supporting means common to said casing, said rotor and said motor means, said supporting means being movable about a pivotal axis perpendicular to the rotational axis of said rotor; and power operated means connected to move said supporting means for varying the inclination of said cutter blades with respect to the earth to be excavated.

4. A device according to claim 3, further comprising a bifurcated member between the legs of which said supporting means is pivotally mounted; and a vertically extending member supporting said bifurcated member at the lower end thereof with the rotational axis of said rotor normally parallel to and spaced from the longitudinal axis of said vertically extending member, said cutting blades extending outwardly beyond said casing for cutting engagement with a vertical surface, said vertically extending member being rotatable about its longitudinal axis through substantially one complete revolution to bring said cutter blades into engagement with the entire bottom area of a bore hole progressively formed by operation of said cutter blades accompanied by downward and rotational movement of said vertically extending member, said power operated means selectively producing an oblique inclination between the longitudinal axis of said vertically extending member and the rotational axis of said rotor.

5. A device according to claim 4, further comprising: a discharge conduit having one end connected to said outlet in said casing, said vertically extending member having an upwardly extending passage formed therein, said passage being closed at its lower end, the other end of said conduit communicating with said passage above said closed end.

6. A device according to claim 3, further comprising: a vehicle; turret means carried by said vehicle for rotation about a vertical axis; second power operated means for rotating said turret means; boom means having one end portion pivotally connected to said turret means for rotation therewith, said pivotally movable supporting means being carried by the other end portion of said boom means; and third power operated means carried by said turret means and connected to said boom means for selectively raising and lowering said cutter blades.



7. A device according to claim 6, wherein said vehicle is a land vehicle, said device further comprising spaced parallel plate members disposed at opposite sides of said cutter blades, said plates being engageable with the walls of a trench formed by operation of said cutter blades accompanied by movement of said vehicle in the longitudinal direction of the trench and vertical displacement of said cutter blades.

8. A device according to claim 6, wherein said vehicle is a boat and in which said boom means includes a parallelogram linkage, said device further comprising a guide member at said other end portion of said boom member; a rod member vertically slidable in said guide member, said rod member being maintained vertical by said linkage, said pivotally movable supporting means being carried by the lower end portion of said rod member; and fourth power operated means for vertically displacing said rod.

9. A device according to claim 3, additionally comprising further supporting means which is movable over the surface of the ground adjacent to a trench to be excavated by said device; winch means carried by said further supporting means; a pulley located above said ground and carried by said further supporting means; a cable passing over said pulley, said cable being wound in and paid out by said winch means; guide means carried by said further supporting means, said guide means being mounted for angular displacement about a horizontal axis which is perpendicular to the rotational axis of said pulley; a rod member having its upper end portion connected to the free end of said cable, said rod member being longitudinally slidable through said guide means; means connecting said pivotally movable supporting means to the lower end portion of said rod member; and a pair of pulleys disposed on opposite sides of said cable beyond said first-named pulley from said winch means for guiding said cable during angular displacement of said supporting means.

10. A device according to claim 3, further comprising sensing means responsible to the power input to said motor means whereby said power operated means may be adjusted to provide an optimum inclination for said cutter blades in accordance with the magnitude of said power input.


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